SCSU CRISP CCSA Teacher Module 2016

Title of Module: Designing Prosthetic Devices

Subject or Unit of Study: Biotechnology

GRADE LEVEL: Middle School and/or High School **LENGTH OF DEMO/LESSON**: ______________________________

STUDENT OBJECTIVES:
Students will be able to:
1) Execute and explain the Engineering Design Process:
   i. Identify a need
   ii. Research the problem
   iii. Design a solution
   iv. Build, test, and evaluate a prototype
   v. Communicate the solution
   vi. Troubleshoot and redesign
2) Design and build a model prosthesis that can perform similar functions to the human hand
3) Recognize design constraints and critically assess design solutions

NEXT GENERATION SCIENCE STANDARDS

NGSS Performance Tasks	**MS-ETS1-2** • Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **HS-ETS1-3** • Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
NGSS Disciplinary Core Ideas (DSI)	**MS-PS1-3** • Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **MS-ETS1-1** • Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-3** • Analyze data from tests to determine similarities and differences among several design solution to identify the best characteristics of each that can be combined into a new solution to better meet criteria for success. **MS-EST1-4** • Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. **HS-ETS1-1**

	• Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. **HS-ETS1-2** • Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. **HS-ETS1-4** • Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
NGSS Cross Cutting Concepts (CCC)	**CC-4: Systems and System Models** • Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows— within and between systems at different scales. (HS-ETS1-4) **CC-2: Cause and Effect** • New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1) (HS-ETS1-3)
NGSS Science and Engineering Practices (SEP)	**SEP 2- Developing and Using Models** • Asking questions (for science) and defining problems (for engineering) Constructing explanations (for science) and designing solutions (for engineering)

COMMON CORE STANDARDS

CC - ELA/Literacy Standards	**RST.11-12.7** • Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),(HS-ETS1-3) **RST.11-12.8** • Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1),(HS-ETS1-3) **RST.11-12.9** • Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. (HS-ETS1-1),(HS-ETS1-3)
CC-Math Standards	**MP.2** • Reason abstractly and quantitatively. (5-PS1-1) **MP.4** • Model with mathematics. (5-PS1-1)

MATERIALS

- Cardboard boxes
- Elastic bands
- Wood pencils
- Binder clips
- Masking tape
- Film ribbon
- Pipe cleaners
- Paper clips
- Straws
- Scissors
- Any other inexpensive basic office or paper materials.

SAFETY

N/A. All materials are standard office items.

LEARNER BACKGROUND

Students should have a foundational understanding of arm/hand anatomy and biomechanics. Basic skills in geometry and algebra coupled with an understanding of physics principles of motion will aid in the successful construction of a model prosthetic hand.

LEARNING ACTIVITY OR PROCEDURE

Students will design a prosthetic device. Students will apply knowledge of human arm/hand anatomy and biomechanics to design, build, and test a hand prosthetic using standard office items. Students will collaborate to decide which combination of materials meet design requirements and generate a prosthetic that is able to grasp, lift, and release akin to the hand. Educators are encouraged to develop extension classroom activities based on supporting content provided in this module.

ASSESSMENT

A useful assessment framework could be a design evaluation, task completion checklist at scheduled checkpoints, a group presentation, or a final written report about the design process.

STEM CAREERS

Bioengineer
Biomedical Engineer
Biomechanical Engineer
Manufacturing Technician
Mechanical Engineer
Occupational Therapist
Orthotist
Physical Therapist
Prosthetist
Research & Development Scientist

ADDITIONAL RESOURCES

Engineering, Go For it! Lesson: Build a Prosthetic Device
http://teachers.egfi-k12.org/lesson-build-a-prosthetic-device/

Pearson Education, Inc. Project STEM. Designing Prosthetic Devices.
http://www.pearsonschool.com/index.cfm?locator=PS14Kt&PMDbProgramID=80564

Rochester Institute of Technology Traveling Engineering Activity Kits (T.E.AK.)
Biomedical Engineering Kit: The Biomechanical Hand and Joint
http://edge.rit.edu/content/TEAK-O/public/kit%20documents/Bio%20Kits/Biomechanical%20Joint/Joint_LessonPlan.pdf

TEACHER NOTES
An interesting extension activity could be a trip to a MakerSpace or public library to use a 3D printer. 3D printing is the new frontier for prosthetics.

http://www.nytimes.com/2015/02/17/science/hand-of-a-superhero.html?_r=0

http://health.usnews.com/health-news/health-wellness/articles/2014/07/16/how-3-d-printing-will-revolutionize-prosthetics

http://enablingthefuture.org/tag/3d-printed-prosthetics/